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THE WEATHER AND CIRCULATION OF JANUARY 1969

Continued Strong High-Latitude Blocking and Flood-Producing Rains in California

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1. MEAN CIRCULATION

Blocking, which had become strong in the Western Hemisphere during December (Green, 1969), increased further during January 1969. The Aleutian ridge continued to build and developed a small High center (see the monthly mean 700-mb map (fig. 1)) with heights as much as 150 m above normal (fig. 2). Anomalous flow from an unusually cold Canadian Arctic source led to frequent intense cyclogenesis just off the Pacific Northwest coast, reflected in a sharp trough with heights 110 m below normal. Flow from a separate center of cyclonic activity north of Hawaii contributed to strong confluence in the California area. This helped produce record-breaking heavy rains and disastrous floods in some areas of the State.

The strongest blocking in the Northern Hemisphere was over Greenland where 700-mb heights averaged 170m above normal for the month (fig. 2). Slightly weaker blocking was located between Spitzbergen and Novaya Zemlya. The magnitude of this extensive high-latitude blocking shows in the zonal profile of sea-level pressure for January 1969 compared with the January normal (fig. 3). Sea-level pressure averaged more than 8 mb above normal north of 60° N. in the western portion of the hemisphere.

Cyclonic activity was stronger than normal in low and middle latitudes from the eastern Atlantic through the Mediterranean, and over eastern Asia where surface Lows cross the cold landmass infrequently during midwinter. The principal 700-mb monthly mean Low center which had been near the Taymyr Peninsula during December

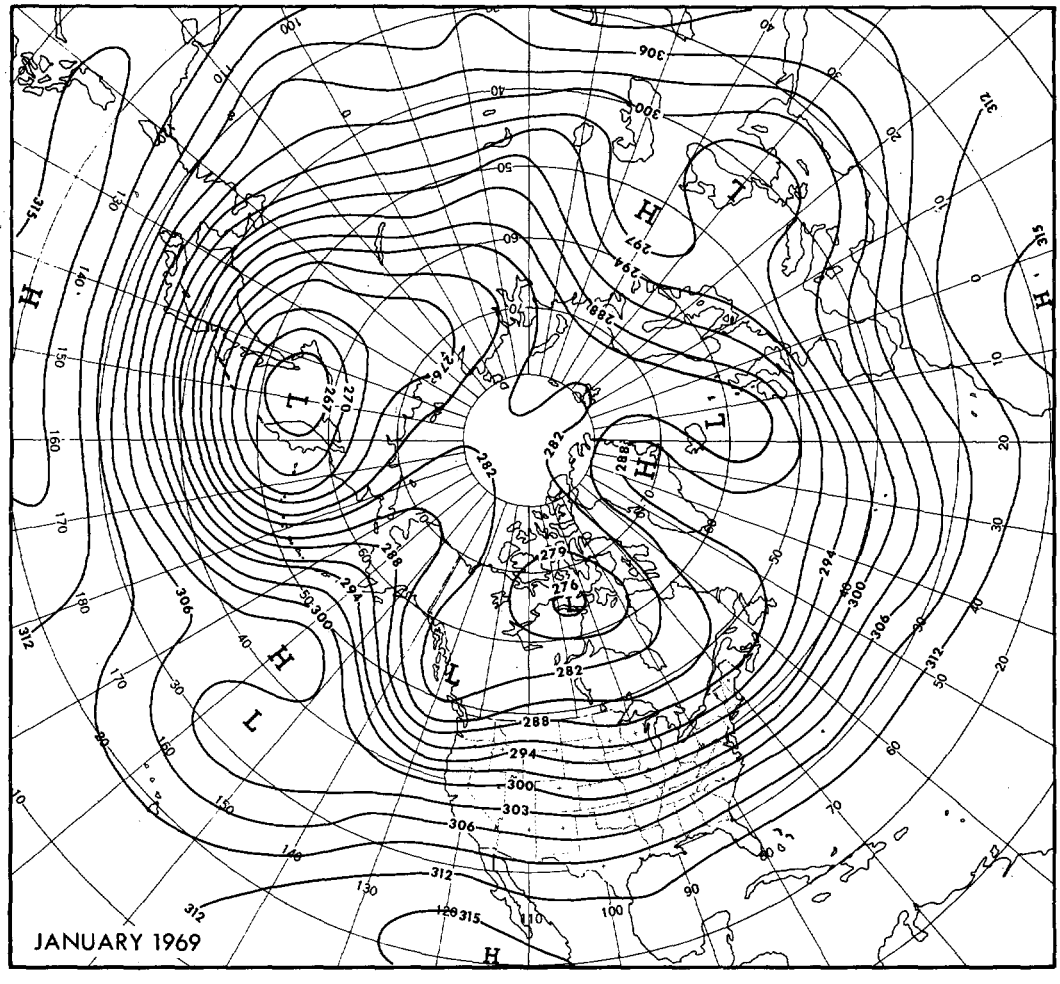


FIGURE 1.—Mean 700-mb contours (decameters) for January 1969.

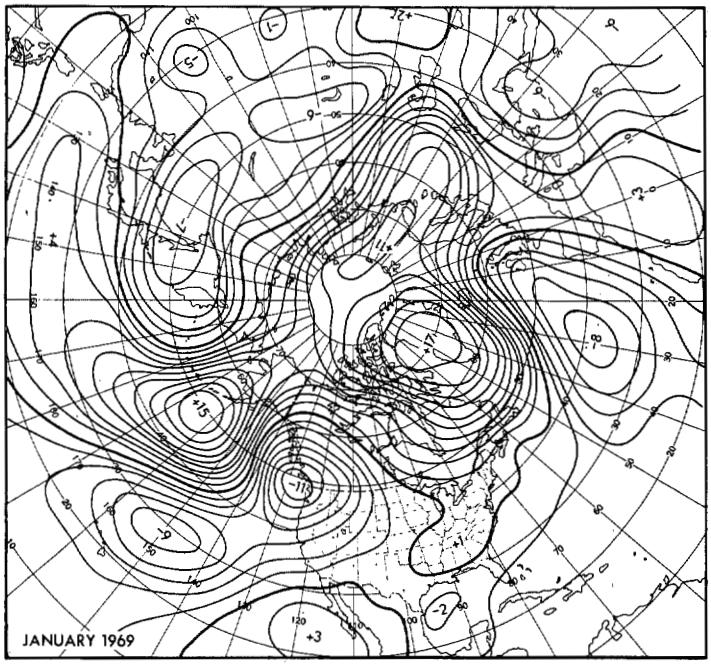


FIGURE 2.—Departure from normal of mean 700-mb height (decameters) for January 1969.

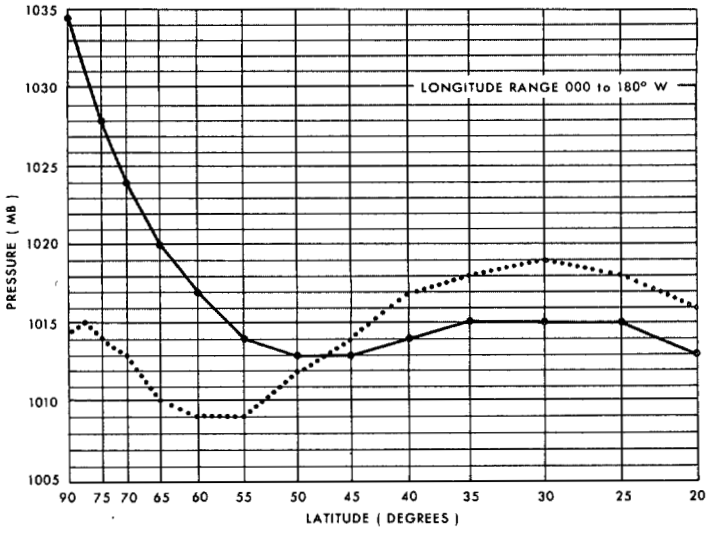


FIGURE 3.—Mean sea level pressure profile for the western half of the Northern Hemisphere between 20° N. and the Pole. Solid line shows observed for January 1969, and dashed line indicates the January normal.

(see fig. 1 in Green, 1969) shifted to the Sea of Okhotsk (fig. 1) as heights fell rapidly over the northwestern Pacific and rose over the Arctic Basin.

The unusual circulation pattern during January 1969 around most of the Northern Hemisphere is demonstrated by the positions of the various branches of the mean jet streams (fig. 4). The westerlies were split into two branches over both oceans; the northern branch was stronger in the Pacific, and the southern branch was stronger in the Atlantic. Over Asia and North America the jet stream was south of its normal position. The strongest anomalies of wind speed were in the Pacific where the blocking High, near the normal position of the jet south of the Aleutians (figs. 1, 4), reduced the mean 700-mb wind speed to 12 m/sec below normal, and the jet east of Hawaii produced a mean wind speed 12 m/sec above normal.

The intensification of the deep and unusual Low north of Hawaii, which was of crucial importance for the disastrous California rains, may be related to the preexistent distribution of sea-surface temperature in that part of the Pacific. During December, ocean temperatures north of Hawaii were more than 4°F above normal (fig. 5A). The normal seasonal southward movement of the westerlies was aided this year by the blocking ridge south of the Aleutians. The usually warm water and enhanced surface thermal gradient to the north of Hawaii may have stimulated abnormally strong cyclogenesis by providing greater than normal sensible and latent heat to the lower atmosphere and impressing a low-level baroclinic field on air masses in the area.

A physically similar situation that occurred somewhat farther north was discussed in more detail by Namias (1963). In that case the center of negative height anomaly was located near 40° N. (compare fig. 8A of Namias, 1963, with figs. 1 and 2) instead of 30° N. The warmest water relative to normal was also located about 10° farther north in 1962 (compare fig. 2 of Namias, 1963, with fig. 5A).

The water temperatures cooled considerably relative to normal during January (fig. 5B) in the area of cyclogenesis north of Hawaii, but remained a few degrees above normal over most of the area from east of Hawaii to the California coast as tropical air was advected northeastward in the strong southwesterly flow at low latitudes (figs. 1 and 2). The abnormally warm water may have increased the moisture content of these air masses above what it would have been otherwise.

Water temperatures were also as much as 6°F above normal in the western Pacific east of Japan (figs. 5A, B). This additional enhancement of the continent-ocean temperature contrast may have further stimulated the intense cyclogenesis that occurred just to the north of that area. However, as Namias (1969) points out, the wintertime variability of the atmosphere is smaller near the Asian coast than over the central Pacific. His hypothesis is that the climatological temperature contrast between continent and ocean is so large that anomalies of water temperature near the coast change the magnitude of the thermal forcing field relatively little in that area. The January 1969, 700-mb height was only 70 m below normal over Sakhalin (fig. 2) compared to 150 m above normal south of the Aleutians and 90 m below normal north of Hawaii.

2. MONTHLY WEATHER

The unusual circulation pattern over the western portion of the hemisphere during January 1969 was related to strong contrast of temperature in the United States. Confluence between Arctic air from Canada and Alaska and subtropical air from the eastern Pacific led to a mild Great Basin and frigid Pacific Northwest and

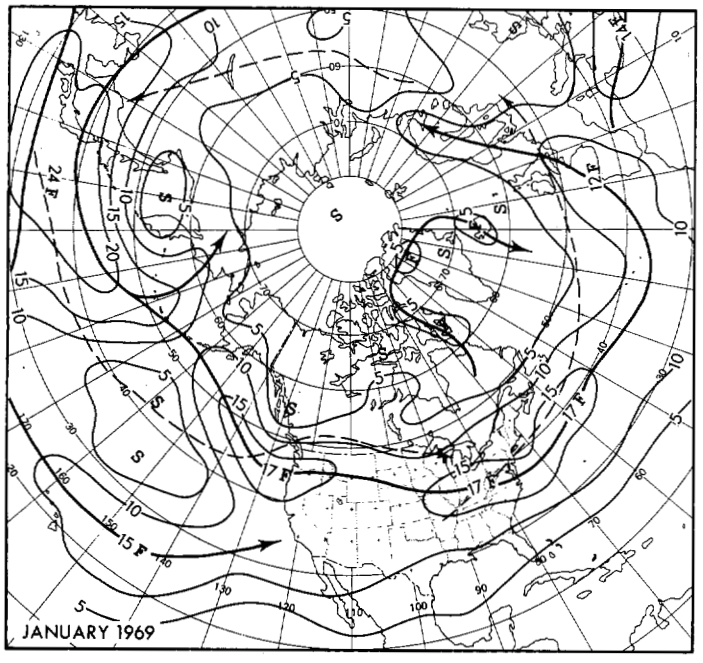


FIGURE 4.—Mean 700-mb geostrophic wind speed (meters per second) for January 1969. Solid arrows show axes of maximum wind speed during January 1969, and dashed arrows indicate normal January positions.

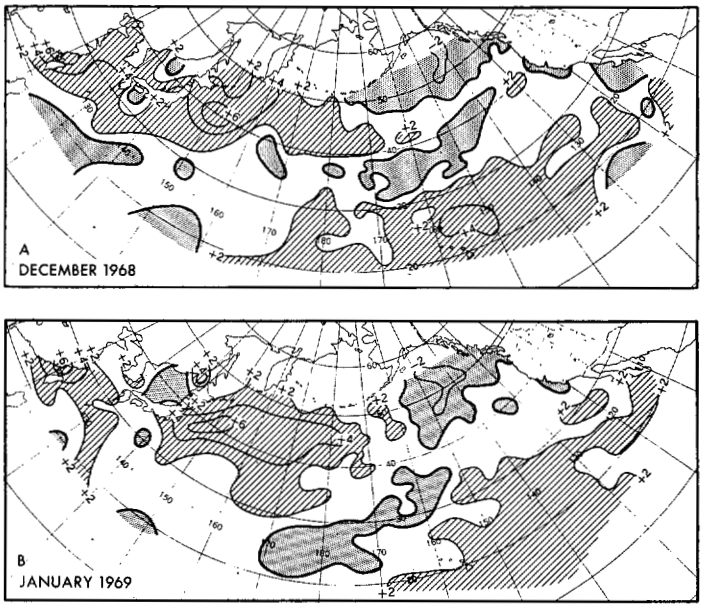


FIGURE 5.—Departure from normal of average sea-surface temperature (°F) in the Pacific Ocean for (A) December 1968 and (B) January 1969. Below normal areas are shaded, and areas more than 2°F above normal have hatched lines (from Renner, 1968 and 1969, and from Japan Meteorological Agency, 1968 and 1969).

northern Rockies (fig. 6). Temperatures were more than 8°F above normal at Winslow, Ariz., and Ely, Nev., the second and third warmest January of record, respectively. In contrast, the monthly mean temperature (−2.8°F) in Great Falls, Mont., was nearly 25°F below normal, and Billings, Mont., had its third coldest January in 35 yr of airport records and the coldest December–January in 75 yr.

Temperatures averaged more than 4°F below normal over the Northern Plains, the Mississippi River Valley, and parts of the Southeast. Mildness in northern New England was due to easterly anomalous maritime flow from the Greenland blocking High (fig. 2). The rest of the Nation east of the Mississippi River had temperatures near or slightly below normal (fig. 6).

Juneau, Alaska, which was under the almost continuous influence of Arctic air, reported its coldest January of record, more than 18°F below normal, and tied the record for dryness since normal Pacific moisture failed to reach the coast. Other stations along the Alaskan coast also reported extreme cold and dryness during January.

The most newsworthy weather items during January 1969 were the heavy rains and floods in southern California. The abnormally strong southwest flow associated with an unusual subtropical branch of the jet stream brought heavy precipitation to California and much of the Nation west of the Divide (figs. 2, 4, 7). Extensive areas had more than twice the normal January precipitation, and parts of southern California received more than four times their January normal (fig. 7). No surface Highs entered the West from the Pacific along the normal primary anticyclone track through Oregon.

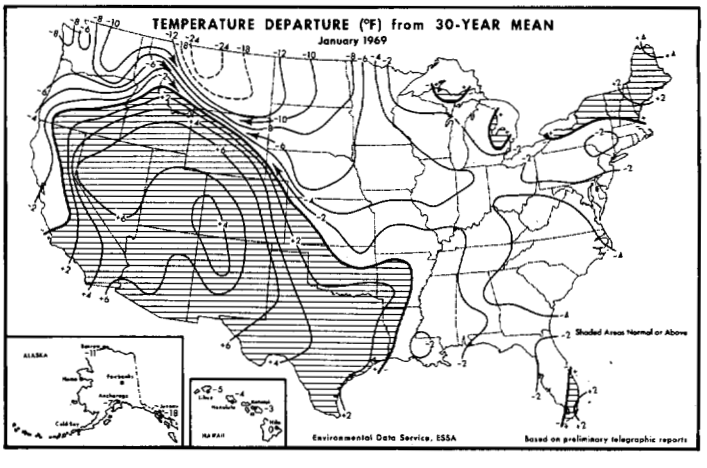


FIGURE 6.—Departure from normal of average surface temperature (°F) for January 1969 (from Environmental Data Service, 1969).

Storms frequently formed to the lee of the Rockies and followed paths towards the Great Lakes, leading to fairly extensive areas of heavy precipitation in the northern Mississippi Valley and parts of the Midwest. Much of this precipitation was in the form of freezing rain. Several cities from central Nebraska to northern Indiana reported glazing conditions on 7 to 11 days.

Many stations from the west coast to the Great Lakes reported the wettest or snowiest January of record, and dozens more had near records. Some of the highlights from these are shown in table 1.

Many localities in the Far West, particularly in and near the Sierras, reported the heaviest seasonal snow accumulations through January 31 in history, well over

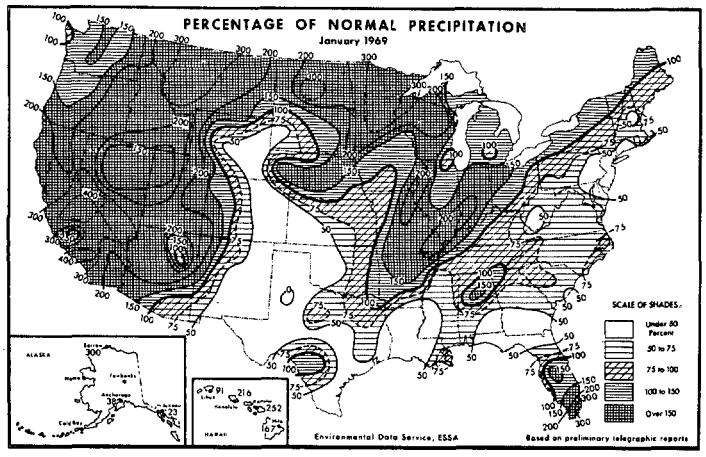


FIGURE 7.—Percentage of normal precipitation for January 1969 (from Environmental Data Service, 1969).

100 in. in some of the passes. Seattle-Tacoma Airport also reported a record seasonal snowfall total of 68 in. and a record total of 20 consecutive days with continuous snow cover of an inch or more. Stampede Pass, Wash., with 171 in. of snow on the ground by January 31, reported measurable precipitation on every day of the month, nearly all of it falling as snow.

Another measure of the storminess of this month is the number of stations that reported unusual amounts of cloudiness or low amounts of sunshine. Olympia, Wash., reported every day as cloudy and had a monthly average sunrise-to-sunset sky cover of 9.7 tenths. Eugene, Oreg., reported no clear days, and Spokane, Wash., only one. Fresno, Calif., had the least sunshine for any month since 1900.

Although Albuquerque, N. Mex., reported only .08-in. precipitation, which was 20 percent of the normal, the number of cloudy days was twice normal, indicating that the "rainshadow effect" was only able to dry out the lower layers of the atmosphere, where most of the precipitable water is found.

Goodland, Kans., reported 14 days of fog, a new record for any month. Omaha, Nebr., had only 22 percent of possible sunshine, the least for any January since 1911. Topeka, Kans., and Huron, S. Dak., set new records for the most cloudy days in January with 22 each.

Cold air aloft, sweeping inland from the Pacific with vigorous short wave troughs, contributed to some unusual convective activity in the West also. Astoria, Oreg., reported hail on 10 days of the month, and thunderstorms with hail were observed twice at Salt Lake City, with January 1969 the second January to have any reports of hail since records have been kept at the airport.

With all the cyclonic activity concentrated in the West and the central part of the Nation, there was a dearth of snow and precipitation in parts of the South and East (fig. 7). Boston, Mass., and Washington, D.C., had less than an inch of snowfall for the month. Providence, R.I., reported the third least snow, and Hartford, Conn., the third least precipitation for any January of record. Port Arthur, Tex., reported the second driest, and Jackson, Miss., the driest January of record.

TABLE 1.—*Selected record or near-record total precipitation and snowfall during January 1969*

Station	Quantity (inches)	Remarks
Los Angeles, Calif.:		
Civic Center	14.94	Wettest January of record
Airport	9.60	do.
Fresno, Calif.	8.56	Wettest January in 91-yr record
Blue Canyon, Calif.	32.41	Wettest January of record
Bishop, Calif.	8.93	Wettest month of record
	23.0	Snowiest January of record
Long Beach, Calif.	11.24	Wettest January of record (since 1942)
Sacramento, Calif.	8.90	Wettest January in 50 yr and 6th wettest of record
Santa Maria, Calif.	7.09	Wettest January in 52 yr and 5th wettest of record
Medford, Oreg.	13.7	Third snowiest month of record and 12 days with measurable snow set new record
Salem, Oreg.	21.9	Third snowiest January of record
Walla Walla, Wash.	4.17	Third wettest January since 1873
	31.3	Snowiest January since 1886
Milford, Utah	1.63	Wettest January in 53 yr
Boise, Idaho	3.50	Wettest January since 1909
Helena, Mont.	2.78	Second wettest January since 1884
	35.6	Snowiest January of record
Missoula, Mont.	2.94	Tied for second wettest January of record
	27.5	Second snowiest January of record
Havre, Mont.	25.2	Snowiest January of record
Kalispell, Mont.	34.2	Second snowiest January of record
Huron, S. Dak.	13.1	do.
St. Cloud, Minn.	2.52	Second wettest January since 1897
Duluth, Minn.	46.8	Snowiest month of record

3. VARIABILITY WITHIN THE MONTH

The circulation over North America underwent a considerable change about the middle of January, so the weather of the first 2 weeks may be discussed in connection with the mean 700-mb heights for the first half of the month. With the aid of an extremely useful technique developed by Booth and Taylor (1968), it is possible to show the mean brightness of the Northern Hemisphere as measured by the ESSA–7 satellite for almost the same period (fig. 8). Of particular interest is the bright area associated with the active trough north of Hawaii where several stations reported heavy rains the first few days of January. The snow cover and cloudiness over the Northwest and Northern Plains stands out as one of the brightest areas of the hemisphere. The southern and eastern United States, which were cold and relatively dry (figs. 9A, B and 10A, B), show up as rather dark areas. Note how the mean brightness increases just off the east coast, near the prevailing trough line (fig. 8) and where convective activity is vigorous when unusually cold air masses move from the continent during winter.

The first 2 weeks of the month were relatively mild over the Far West and cold from the Divide to the Atlantic coast, as anticyclonic conditions prevailed over the Rockies and the blocking High over Greenland trapped a closed Low near the Gulf of St. Lawrence. This brought Arctic air into the East in strength (figs. 9A and 10A). Heavy precipitation, except for a small area near the Gulf Coast, was confined to the Pacific Northwest during the first week of the month. During the second week

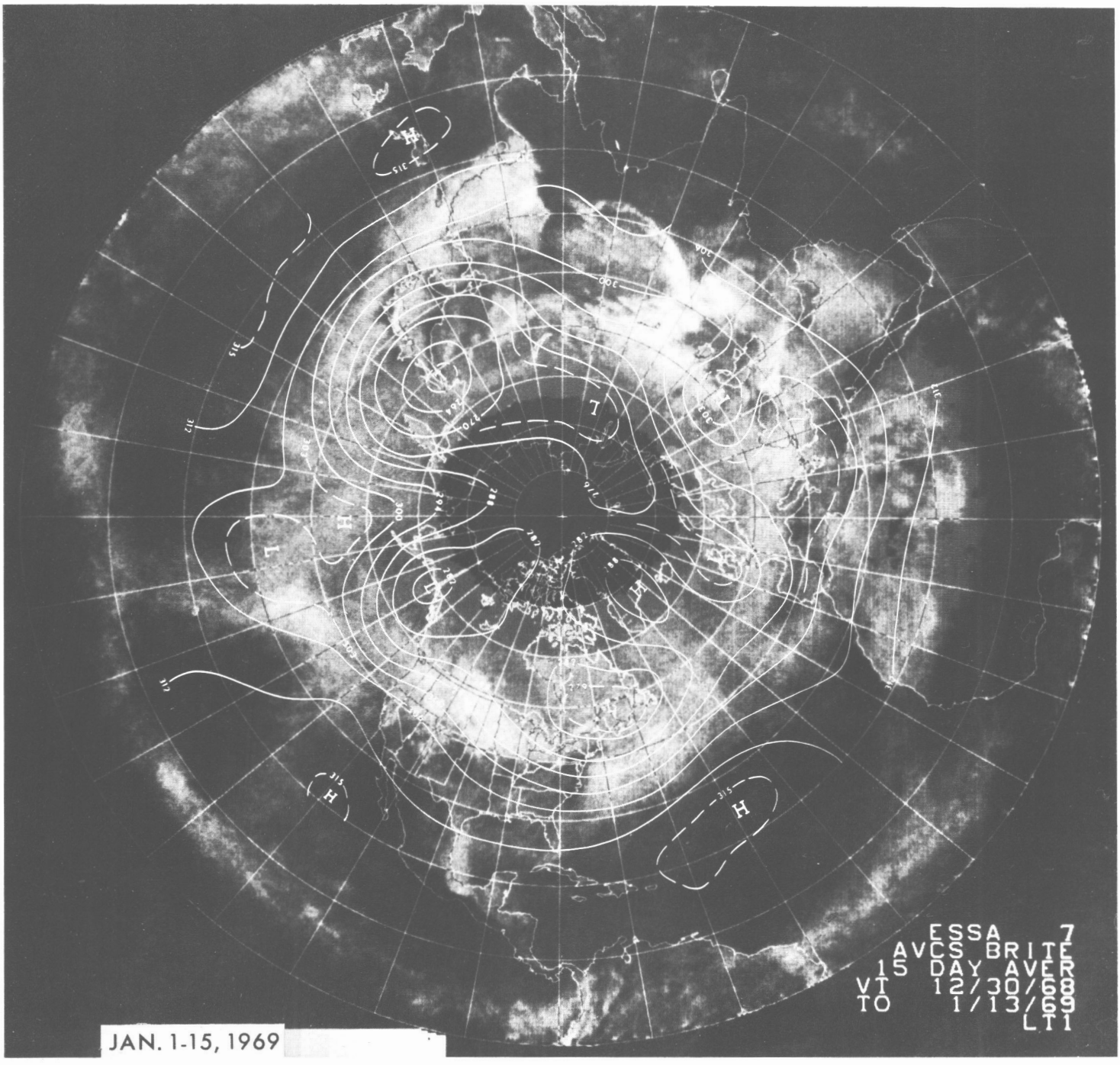
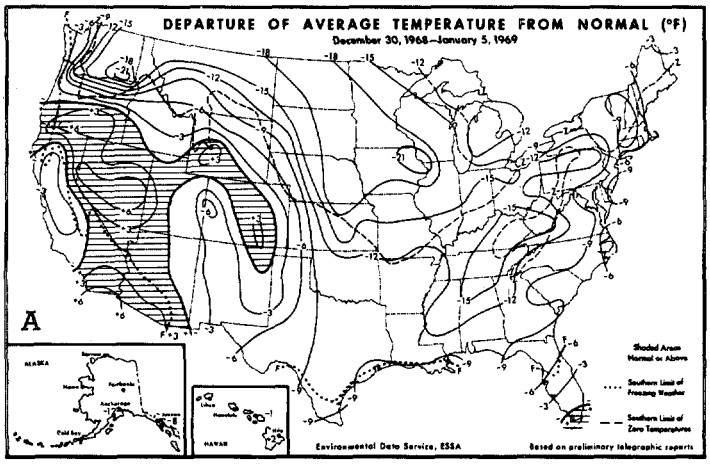


FIGURE 8.—Mean 700-mb contours (decameters) for Jan. 1–15, 1969, superimposed upon mean brightness composite photograph of daily observations from the ESSA–7 satellite for Dec. 30, 1968–Jan. 13, 1969.

(figs. 9B and 10B), rain moved southward into northern California as the flow began to change from anticyclonic to cyclonic.

During the first few days of the month, extremely low temperatures were observed in the interior of Alaska. New daily minimum records were established at Fairbanks the first 5 days of January, with the coldest being −61°F on the 2d. Tanana reported minima below −60°F on the first 3 days, with the 2d having a mean of −61°F and a minimum of −63°F. New daily minimum records were also established at several stations in the eastern and southern United States during the first week of the month.

A vigorous burst of warmth crossed the southern Rockies on the 7th and 8th of January in an extremely strong westerly flow. A maximum temperature of 64°F on the 7th was the warmest ever observed in January in 32 yr of record at Wendover, Utah. The next day in Texas, readings of 87°F at Wichita Falls, 88°F at Dallas, and 90°F at San Angelo equaled the record highs for January, and a temperature of 82°F at Lubbock estab-



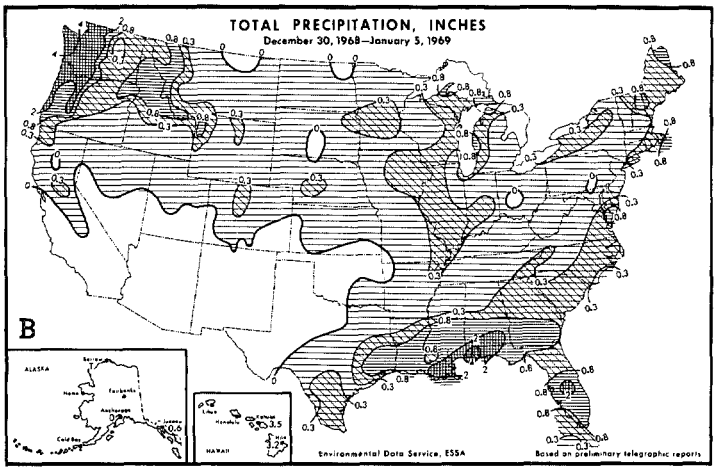
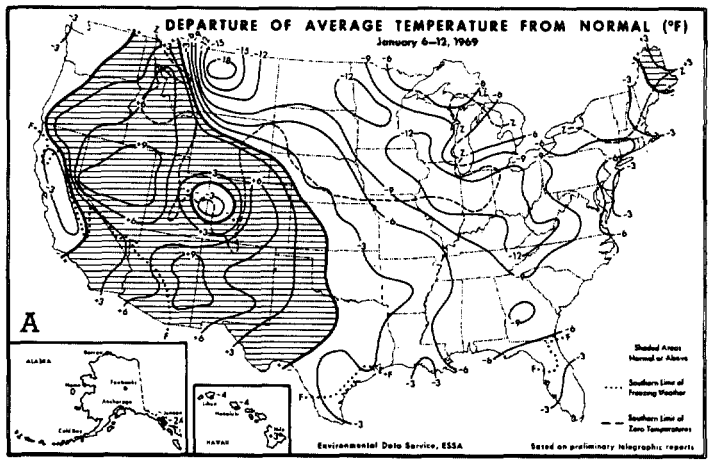


FIGURE 9.—(A) departure from normal of average surface temperature (°F) and (B) total precipitation (inches) for week of Dec. 30, 1968–Jan. 5, 1969 (from Environmental Data Service, 1969).



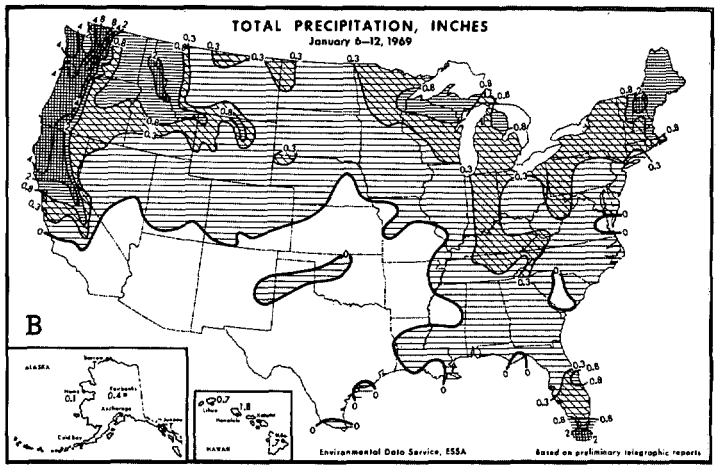


FIGURE 10.—(A) and (B) same as figure 9, for week of Jan. 6–12, 1969 (from Environmental Data Service, 1969).

lished a new mark for January warmth. Damaging winds were observed at several places in eastern Colorado, with peak gusts over 100 mi hr^{-1} at Boulder.

Large changes in the circulation occurred between the first and second halves of January. Half-monthly mean 700-mb heights fell by 250 m in the western Bering Sea and forced the Aleutian ridge eastward. Heights increased 190 m in the Gulf of Alaska. The Hawaiian trough moved eastward and joined the west coast trough to produce the record-breaking rains and floods in southern California (figs. 11, 12).

The center of blocking moved southward from Greenland to eastern Canada, and 700-mb heights rose 210 m over Maine. Temperatures moderated rapidly over the eastern United States (figs. 13A, 14A), but Arctic air persisted in the Northwest and Northern Plains.

The eastward progression of the Hawaiian trough shows clearly on the ESSA–7 mean brightness photograph with the brightest area in the region of strong southwesterly flow (fig. 12). Note the unusual darkness of the eastern Gulf of Alaska where abnormally strong transport of

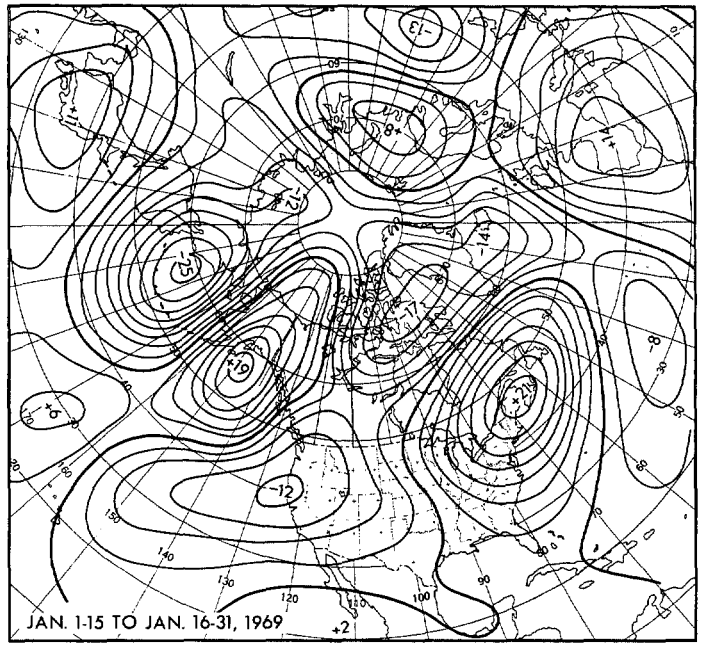


FIGURE 11.—Change in half-monthly mean 700-mb height (decameters) between Jan. 1–15 and Jan. 16–31, 1969.

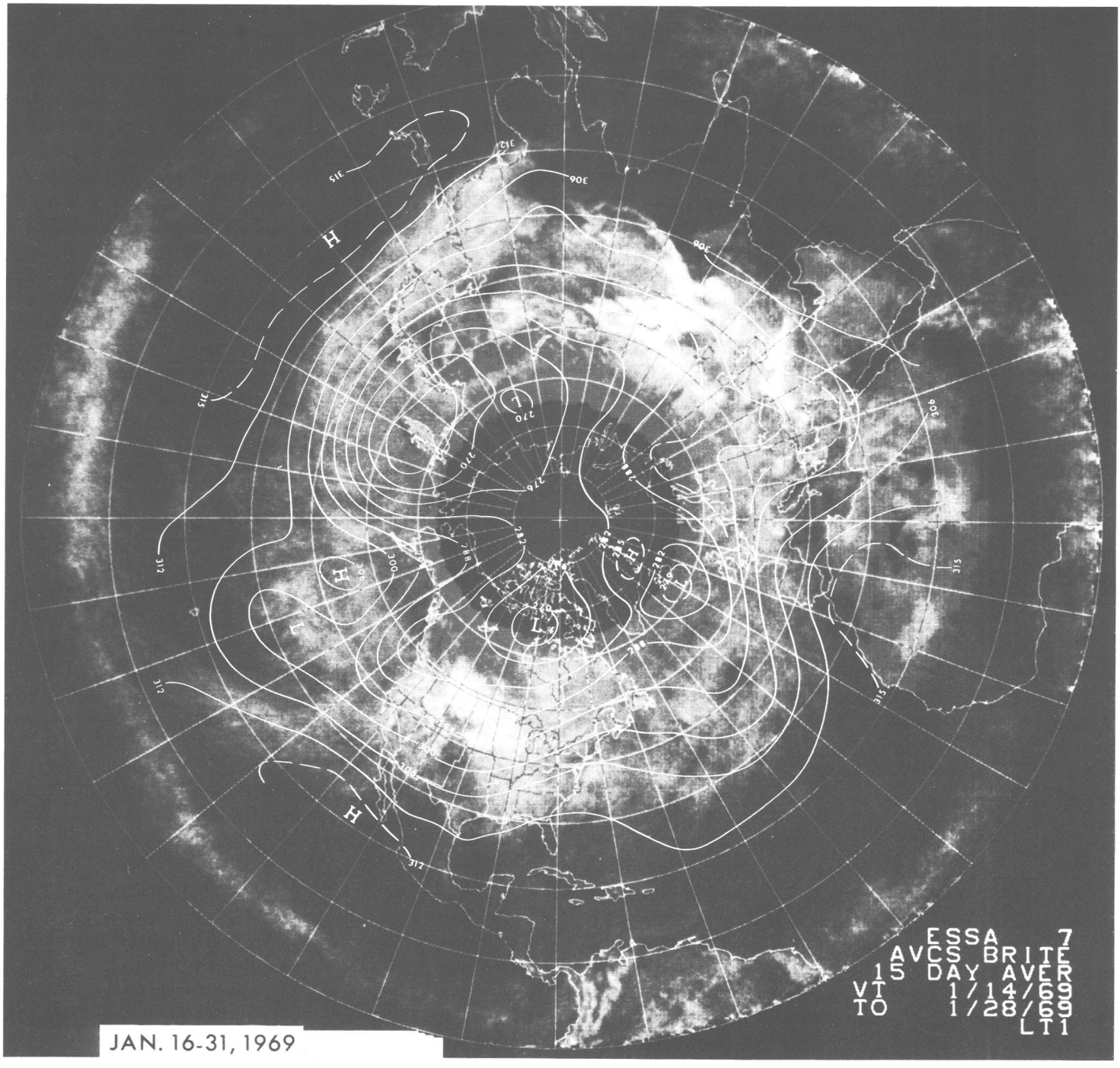


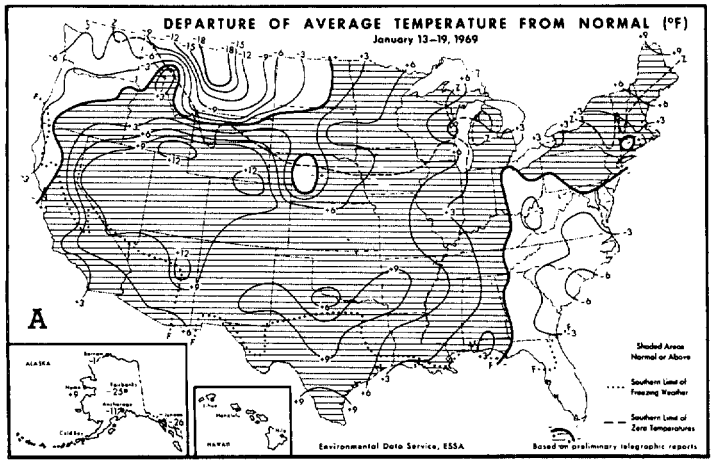
FIGURE 12.—Same as figure 8; contours for Jan. 16–31, 1969, and photograph for Jan. 14–28, 1969.

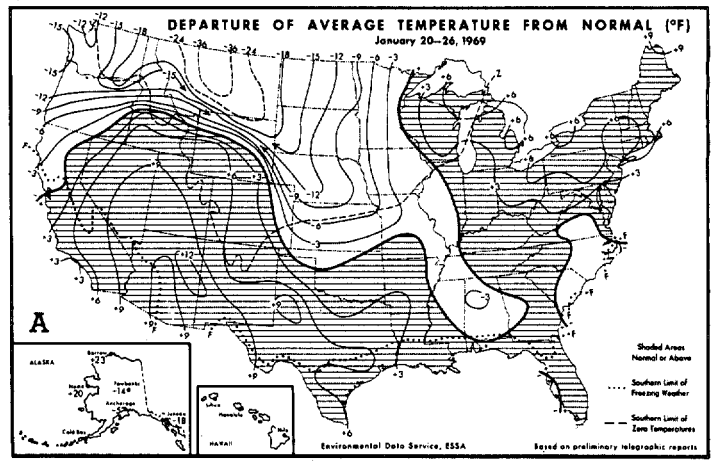
dry Arctic air in a northerly flow with only slight cyclonic curvature kept this usually cloudy region relatively cloud free.

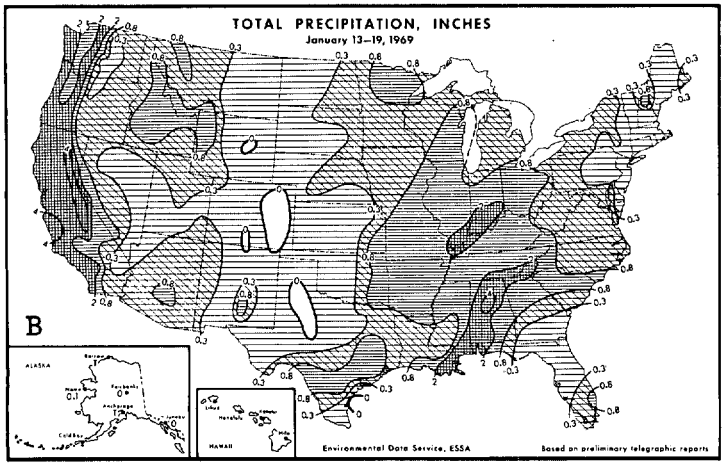
The snowy and stormy Northern Plains showed up even brighter during the second half of the month, and moderately increased brightness over the South and East were related to increased precipitation and cloudiness in those areas (figs. 13B, 14B).

The heaviest rains in California fell during the fourth week, with more than 12 in. in some coastal areas (fig. 14B). Bishop, Calif., established a January 24-hr maximum snowfall record of 18.0 in. and Fresno, Calif., a January 24-hr maximum rainfall record of 2.59 in. on the 24th and 25th of the month.

Several records for persistent cold were established in the Northwest. Seattle reported 10 consecutive days







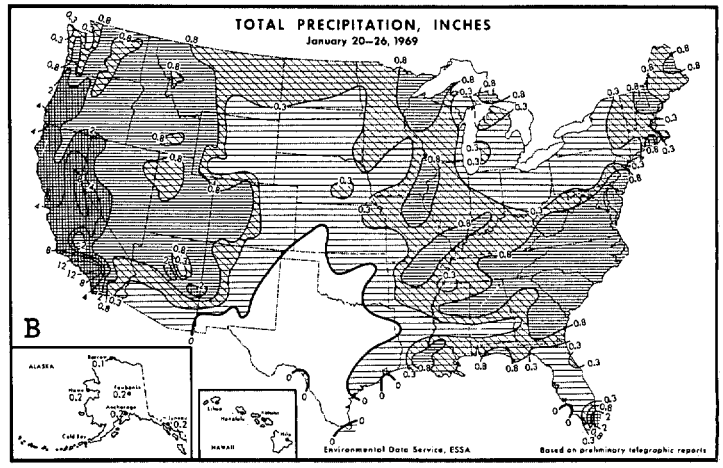


FIGURE 13.—(A) and (B) same as figure 9, for week of Jan. 13–19, 1969 (from Environmental Data Service, 1969).

FIGURE 14.—(A) and (B) same as figure 9, for week of Jan. 20–26. 1969.

during which the temperature failed to rise above freezing and Sheridan, Wyo., had 16 consecutive subfreezing days. The latter station also reported 19 days in all throughout the month in which the minimum temperature was below zero, compared to a normal of six. Numerous daily low temperature records were also established during the last week of January at Havre, Mont., and Williston, N. Dak.

After the Hawaiian trough moved eastward toward California, the southward advection of relatively cool air from the north and daytime cloudiness associated with lingering instability in the still cyclonic flow combined to set many daily low records for maximum, minimum, and mean temperature in Hawaii. A new all-time low temperature record of 48°F was established at Kahului on the 20th, and new January minima were set at Lihue (50°F) on the 22d and at Hilo (54°F) on the 23d.

An unusual January tropical storm, Phyllis, moved through the western Pacific at very low latitudes and reached typhoon intensity for a while. January records were set for fastest 1-min wind speed (55 mi hr^{-1}), 24-hr precipitation (3.66 in.), and lowest sea-level pressure (29.34 in.) at Kwajalein Island as it passed 25 mi to the north.

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